

**Recovery Plan for *Astrophytum asterias* (Star Cactus)**

**Original Approved: August 26, 2003**

**Original Prepared by: Loretta Schanen Pressly (U.S. Fish and Wildlife Service, Corpus Christi, TX)**

**DRAFT AMENDMENT 1**

We have identified best available information that indicates the need to amend recovery criteria for this species since the Star Cactus (*Astrophytum asterias*) Recovery Plan (Recovery Plan) was completed. In this proposed modification, we synthesize the adequacy of the existing recovery criteria, show amended recovery criteria, and the rationale supporting the proposed recovery plan modification. The proposed modification is shown as an appendix that supplements the Recovery Plan, superseding only the Executive Summary, page iii, and Section II, pages 11-14 (U.S. Fish and Wildlife Service (Service) 2003, pp. iii and 11-14).

**For  
U.S. Fish and Wildlife Service  
Southwest Region  
Albuquerque, New Mexico**

**September 2018**

Approved: \_\_\_\_\_ DRAFT \_\_\_\_\_ Date: \_\_\_\_\_  
Regional Director, Region 2  
U.S. Fish and Wildlife Service

**BACKGROUND INFORMATION**

Recovery plans should be consulted frequently, used to initiate recovery activities, and updated as needed. A review of the recovery plan and its implementation may show that the plan is out of date or its usefulness is limited, and therefore warrants modification. Keeping recovery plans current ensures that the species benefits through timely, partner-coordinated implementation based on the best available information. The need for, and extent of, plan modifications will vary considerably among plans. Maintaining a useful and current recovery plan depends on the scope and complexity of the initial plan, the structure of the document, and the involvement of stakeholders.

An amendment involves a substantial rewrite of a portion of a recovery plan that changes any of the statutory elements. The need for an amendment may be triggered when, among other possibilities: (1) the current recovery plan is out of compliance with regard to statutory requirements; (2) new information has been identified, such as population-level threats to the species or previously unknown life history traits, that necessitates new or refined recovery actions and/or criteria; or (3) the current recovery plan is not achieving its objectives. The

amendment replaces only that specific portion of the recovery plan, supplementing the existing recovery plan, but not completely replacing it. An amendment may be most appropriate if significant plan improvements are needed, but resources are too scarce to accomplish a full recovery plan revision in a short time.

Although it would be inappropriate for an amendment to include changes in the recovery program that contradict the approved recovery plan, it could incorporate study findings that enhance the scientific basis of the plan, or that reduce uncertainties as to the life history, threats, or species' response to management. An amendment could serve a critical function while awaiting a revised recovery plan by: (1) refining and/or prioritizing recovery actions that need to be emphasized, (2) refining recovery criteria, or (3) adding a species to a multispecies or ecosystem plan. An amendment can, therefore, efficiently balance resources spent on modifying a plan against those spent on managing implementation of ongoing recovery actions.

### **METHODOLOGY USED TO COMPLETE THE RECOVERY PLAN AMENDMENT**

The process of review and modification of the existing recovery criteria for the star cactus was initiated using the 2013 status review (5-year review) as a foundation document because it was more recent than the recovery plan (Service 2013: entire). This status review was also comprehensive with regard to all information known about this species through the time period ending in 2012. To determine if new information had become available since completion of the 5-year review, inquiries were made with other Service staff (National Wildlife Refuge) and external partners regarding field work, surveys, research projects, botanical garden seed work, or other types of efforts that may have been undertaken between 2013 and June 2018. Additionally, we reviewed our files and conducted online searches for information that may have become available between 2013 and 2018.

In addition to the information review, the Service relied on the South Texas Plant Recovery Team (STPRT) for assistance in modifying recovery criteria for the Recovery Plan. The STPRT was formed in 2010 to oversee the recovery of nine species of listed plants in South Texas, including star cactus. On June 12-13, 2018, the STPRT met at Santa Ana NWR to develop proposed recovery criteria revisions for the star cactus and two other listed plant species. Seven team members attended, including two private citizen botanists, three former or current university botanists, a Texas Parks and Wildlife Department (State) botanist, and a Service plant ecologist. Nine other Service employees also attended, including the Service's liaison to the recovery team and the Service's species lead for the three plants. There was an open discussion among all members, led by the Service's species lead and team liaison. The discussion was guided by an agenda with stated objectives, Google Earth files showing known population or metapopulation locations, and handouts of species information, existing criteria, and Endangered Species Act definitions. Following the meeting, Service biologists emailed meeting notes, and a draft table displaying existing versus proposed criteria developed during the meeting, to all team members (including members who were unable to attend the meeting in person) requesting review and comment. The proposed recovery criteria amendments will require formal peer review due to the modification of the original downlisting criteria and the establishment of new delisting criteria where none had existed in the original recovery plan. By using the STPRT, the Service was able to inform the State, non-governmental organizations, and the private sector

about the proposal to revise recovery criteria and to involve experts from these stakeholder groups in the actual modification process.

### **ADEQUACY OF RECOVERY CRITERIA**

Section 4(f)(1)(B)(ii) of the Endangered Species Act (Act) requires that each recovery plan shall incorporate, to the maximum extent practicable, “objective, measurable criteria which, when met, would result in a determination...that the species be removed from the list.” Legal challenges to recovery plans (see *Fund for Animals v. Babbitt*, 903 F. Supp. 96 (D.D.C. 1995)) and a Government Accountability Audit (GAO 2006) also have affirmed the need to frame recovery criteria in terms of threats assessed under the five delisting factors.

### **Recovery Criteria**

The original Recovery Plan defined criteria for downlisting to threatened, but did not include criteria for delisting. The primary objective for the Recovery Plan is to ensure survival and promote recovery of star cactus in its natural habitat such that the species can be reclassified to threatened status. The Recovery Plan further states that the completion of criteria for downlisting to threatened would enable the development of a full recovery strategy and delisting criteria (U.S. Fish and Wildlife Service 2003, p. 11). See previous version of criteria in the Recovery Plan on pages 11-14.

### **Synthesis**

The STPRT reviewed relevant research and unpublished information and shared their expert opinions to propose amended recovery criteria and updates to the status and threats assessment. The following is a summary of relevant information used by the STPRT to develop proposed updates.

Star cactus sites are located in the U.S. and Mexico, occurring within at least three different geologic formations and/or soils. Since the publication of the Recovery Plan, research examining five subpopulations of star cactus in Texas found that four of the five were genetically diverse (high level of heterozygosity within the subpopulations), but not genetically distinct (low level of genetic differentiation between the subpopulations) (Terry et al. 2012, p. 182; South Texas Plant Recovery Team 2018, unpaginated). The low levels of genetic differentiation among the subpopulations sampled (Terry et al. 2012, p. 187) indicates that star cacti occurring in the border region of Texas are likely a single population. This is not surprising, given that almost all of the known star cactus locations in the U.S. are located within only about a 125-km<sup>2</sup> area.

### *Threats Assessment*

All known populations of star cactus occur on private land, where state and federal regulations provide only minor protection to endangered plants (U.S. Fish and Wildlife Service 2013, pp. 19-20). Continued threats from energy-related development in Starr County now includes wind power (N. Elizondo, Starr County Industrial Foundation pers. comm. 2018, unpaginated). Energy-related development can directly affect star cacti and star cactus habitat located on private lands (Reemts et al. 2014, pp. 123 and 125). According to Sonia Najera (TNC, pers. comm. 2018), the installation of service roads and other permanent structures can also have indirect effects on surrounding habitats containing rare plants by altering the area’s hydrology.

For example, elevated service roads within wind farms can potentially divert and channel water through drainage culverts thereby changing water surface flow and soil erosion rates.

Potential impacts related to the construction and presence of a border wall are unknown. Given that all known populations of star cactus in Texas are on privately owned land, it is possible that unexplored but suitable star cactus habitat occurs in areas identified for new segments of the border wall. Depending upon its design and location relative to star cactus sites, the border wall could also potentially influence the dispersal of pollen or movements of star cactus pollinators (South Texas Plant Recovery Team 2018, unpaginated).

The widespread decline of bees (Stokstad 2007, p. 970; Cameron et al. 2011, p. 662) and other pollinators is a threat to the star cactus due to its dependence upon pollinators, primarily cactus-specialist bees, to transfer pollen for seed production (Janssen et al. 2010, p. 97). Strong and Williamson (2007, p. 344) suggested that low numbers of pollinators in their Starr County study site might explain why significantly more fruits and seeds were produced by hand-pollinated star cactus compared to controls that were open and available for visitation by natural pollinators.

Climate change may affect star cactus populations and distribution, as the frequency and duration of drought is projected to increase (U.S. Fish and Wildlife Service 2013, pp. 21-23). In Mexico, researchers identified star cactus as a species that will experience increasingly unsuitable conditions due to the increase of temperature and reduction in precipitation associated with climate change (Carrillo-Angeles et al. 2016, p. 310).

Las Estrellas Preserve, managed by The Nature Conservancy (TNC), is a fully protected star cactus site in Starr County, Texas. A conservation organization has proposed fee title acquisition in the near term of another privately owned star cactus site in Starr County and has made arrangements with TNC for its management. If this acquisition comes to fruition, this locality would constitute a second fully protected site for star cactus.

#### **AMENDED RECOVERY CRITERIA**

Recovery criteria serve as objective, measurable guidelines to assist in determining when an endangered species has recovered to the point that it may be downlisted to threatened, or that the protections afforded by the Act are no longer necessary and the star cactus may be delisted. Delisting is the removal of a species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Downlisting is the reclassification of a species from endangered to threatened. The term “endangered species” means any species (species, sub-species, or DPS) which is in danger of extinction throughout all or a significant portion of its range. The term “threatened species” means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

We provide downlisting criteria for the star cactus, which will supersede those included in the original Recovery Plan (Service 2003, pp. iii and 11-14), and introduce delisting criteria for the species as follows:

## Downlisting Recovery Criteria

### Current recovery criteria

1. Maintain or establish ten geographically distinct, fully protected, self-sustaining populations of star cactus in the United States or Mexico, each with a minimum of 2,000 individuals and an age class structure reflecting that plants are reproducing and becoming naturally established within the population.
2. Develop and implement a formal conservation agreement for star cactus between the United States and Mexico.

### Amended recovery criteria

1. Maintain or establish at least 5 sites (>1 km of separation between sites) within each of a total of 3 designated recovery units in Texas and Mexico. Recovery units will be based on geology and/or soils. Each site will contain at least 2,500 individuals, 50% of which will be of reproductive age as determined by a size of  $\geq 3.5$  cm diameter. The sites must occur across the species known range within each recovery unit; however, coalescence of sites due to recovery or discovery of new sites will not reduce the number of recognized sites.

Justification: The leading threat to star cactus throughout its range currently, and at the time of listing, is habitat loss. The STPRT proposes five sites within each of three recovery units to maintain species redundancy and representation across geographically diverse areas. Based on recent genetic studies (Terry et al. 2012, p. 182; South Texas Plant Recovery Team 2018, unpaginated), the STPRT proposes to use the term “sites” instead of “populations” to specify recovery criteria within designated recovery units. The term “sites” clarifies the criteria by allowing the STPRT to count clusters or groupings of star cactus located at least 1 km apart (NatureServe 2004, unpaginated) while avoiding the uncertainty of which groupings may or may not constitute a scientifically valid population.

The original recovery criteria called for an MVP of 2,000 individuals based upon standard guidelines for calculating MVP for rare plants (Pavlik 1996, p. 137). However, the STPRT proposes an MVP of 2,500 for star cactus due to concerns about low survivorship of this species. A minimum of 50% reproductively mature plants reflects the age class structure needed to demonstrate that plants are reproducing and becoming naturally established within the site. Research indicates that star cactus individuals reach maturity upon attaining a diameter of at least 3.5 cm (Birnbaum 2009, p. 49; Janssen et al. 2010, pp. 76-78; U.S. Fish and Wildlife Service 2013, pp. 10-11).

2. All sites described above in downlisting criterion 1 must be fully protected and managed appropriately for the species, its habitat, and pollinators.

Justification: There are few regulatory mechanisms available that provide protection for listed plants that occur on private lands. The STPRT recommends that fully protected sites include management and protection of star cactus individuals, habitat, and pollinators. Fully

protected is defined as management of populations on Federal or State lands as part of an approved management plan (e.g., National Wildlife Refuge Comprehensive Conservation Plan), or a formal stewardship agreement for private landowners that includes management and monitoring of the populations, habitat, and threats. Management should include measures to lessen or alleviate relevant threats (e.g. habitat loss or collection pressure) to star cactus and to measure the species' numbers, habitat quality, and threats (U.S. Fish and Wildlife Service 2003, p. 12). Based upon findings by Janssen et al. (2010, p. 97), the specialist bee *Diadasia rinconis* and other species of cactus bees, rely upon adequate nesting sites and the presence of multiple species of cacti blooming throughout their foraging season to provide a continuous source of pollen (Janssen et al. 2010, p. 97). Whenever possible, fully protected sites should also include buffers of undisturbed habitat around star cactus locations to prevent invasive grasses or other threats from encroaching (South Texas Plant Recovery Team 2018, unpaginated).

3. Develop and implement a formal conservation agreement for star cactus between the U.S. and Mexico.

Justification: The range of the star cactus spans the border between the United States and Mexico, and the status of star cactus in each country is important for the overall conservation of the species. A binational conservation agreement for the species should be coordinated through the Trilateral Agreement, a Memorandum of Star Cactus Recovery Plan August 2003 -14- Understanding between Canada, Mexico, and the United States for transnational species' conservation. This coordination will provide (further) protective measures for the species and may be integral for range-wide recovery, as significant opportunities for recovery projects may exist outside of the United States.

### **Delisting Recovery Criteria**

#### Current recovery criteria

None

#### Amended recovery criteria

1. Over a 60-year period, maintain the 5 fully protected sites in each designated recovery unit at the MVP of 2,500 individuals per site with at least 50% being of reproductive age. All sites will be fully protected, self-sustaining sites occurring across the species known range within each recovery unit.

Justification: The STPRT estimates that trend detection will require periodic monitoring through at least 3 generations. Based upon growth rate data, it takes 15-25 years for star cactus to reach maturity (Birnbaum 2009, p. 49; Janssen et al. 2010, pp. 76-78; U.S. Fish and Wildlife Service 2013, pp. 10-11). Therefore, at an average of 20 years per generation, a 60-year time span (3 generations x 20 years) is necessary to ensure the species is sufficiently resilient to withstand stochastic events.

All classification decisions consider the following five factors: (1) is there a present or threatened destruction, modification, or curtailment of the species' habitat or range; (2) is the species subject to overutilization for commercial, recreational scientific or educational purposes; (3) is disease or predation a factor; (4) are there inadequate existing regulatory mechanisms in place outside the ESA (taking into account the efforts by states and other organizations to protect the species or habitat); and (5) are other natural or manmade factors affecting its continued existence. When delisting or downlisting a species, we first propose the action in the *Federal Register* and seek public comment and peer review. Our final decision is announced in the *Federal Register*.

### **Rational**

Representation across geographically diverse areas within the species range increases the species' ability to adapt to change. Therefore, the STPRT proposes 5 sites within each of three Recovery Units, with the Recovery Unit locations defined by geology and soils. The use of Recovery Units will result in one or more fully protected MVPs in both countries to achieve downlisting.

The STPRT proposes an MVP of 2,500 individuals due to concerns about low survivorship of star cactus. In 2007, 240 star cactus seedlings were reintroduced to Las Estrellas Preserve, a protected area containing a naturally occurring population of star cactus. After 14 months, approximately 64% of the seedlings survived, but 5 years post-planting only 14% remained (Birnbaum 2009, p. 44; Texas Parks and Wildlife Department 2012, unpaginated). A similar project, also conducted at Las Estrellas Preserve, reported 52% seedling survival after 1.5 years (Reemts et al. 2014, p. 122).

Although many cactus individuals can survive for many decades, the STPRT proposes delisting recovery criteria that achieves an MVP over a 60-year time span (3 generations). A generation span is the time required for a newly formed seed to disperse, germinate, grow to a mature size, flower, and disperse new seeds.

The term "sites" clarifies the criteria by allowing clusters or groupings of star cactus located at least 1 km apart (NatureServe 2004, unpaginated) to be counted while avoiding the uncertainty of which groupings may or may not constitute a scientifically valid population. However, the discovery or restoration of a new star cactus site within 1 km of two previously recognized sites (i.e., coalescence) will not result in the reduction of the total number of sites to one (South Texas Plant Recovery Team 2018, unpaginated).

Star cactus reintroduction may be a viable option to restore or supplement numbers of star cactus in its historical range. Birnbaum et al. (2011, p. 43) found that seedlings have a much higher survival rate than seeds within the first 14 months. Reemts et al. (2014, p. 122) reported that after 1.5 years, about half of the 5-year old greenhouse-raised star cacti relocated to areas with historical populations were still alive and had grown in size. Reintroduction may be a viable strategy for achieving fully protected star cactus sites; however, long-term success of reintroduced plants is still unknown and an approved reintroduction plan for this species is needed. As of 2018, star cactus does not occur on refuge tracts in Starr County, but refuge land may provide fully protected sites in the future using reintroduced plants.

## LITERATURE CITED

- Birnbaum, S.J., J.M. Poole, and P.S. Williamson. 2011. Reintroduction of star cactus *Astrophytum asterias* by seed sowing and seedling transplanting, Las Estrellas Preserve, Texas, USA. *Conservation Evidence* 8:43-52.
- Cameron, S.A., J.D. Lozier, J.P. Strange, J.B. Koch, N. Cordes, L.F. Solter, and T.L. Griswold. Patterns of widespread decline in North American bumble bees. *Proc. Natl. Acad. Sci. (PNAS)* 108(2):662-667.
- Carrillo-Angeles, I.G., H.Suzan-Azpiri, M.C. Mandujano, J. Golubov, and J.G. Martinez-Avalos. 2016. Niche breadth and the implications of climate change in the conservation of the genus *Astrophytum* (Cactaceae). *J. Arid Env.* 124:310-317.
- Janssen, G.K., P.S. Williamson, J.M. Poole, S. Birnbaum, A.W. Ferguson, A.W. Strong, and A.W. Blair. 2010. The research and recovery of star cactus (*Astrophytum asterias*). Final Report. #E-46WFR02 #126181. Texas Parks and Wildlife Department, Austin, Texas.
- NatureServe. 2004. Habitat-based plant element occurrence delimitation guidance. <http://help.natureserve.org/biotics/Content/Methodology/PlantEOSpecs.htm>. Accessed 13 June 2018.
- Pavlik, B.M. 1996. A framework for defining and measuring success during reintroductions of endangered plants. *In* D. Falk, C. Millar, and P. Olwell [eds.], *Restoring diversity: strategies for reintroduction of endangered plants*, 127–156. Island Press, Washington, D.C., USA.
- Reemts, C.M., P. Conner, G.K. Janssen, and K. Wahl. 2014. Survival of planted star cactus, *Astrophytum asterias*, in southern Texas. *Southwestern Nat.* 59(1):122-125.
- South Texas Plant Recovery Team. 2018. Meeting notes from recovery team meeting at Santa Ana National Wildlife Refuge, June 12-13, 2018.
- Stokstad, E. 2007. The case of the empty hives. *Science* 316:970-972.
- Strong, A.W. and P.S. Williamson. 2007. Breeding system of *Astrophytum asterias*: an endangered cactus. *Southwestern Nat.* 52(3):341-346.
- Terry, M.K., A.E. Pepper, A.W. Strong, D.M. Tarin, D.M. Price, and J.R. Manhart. 2012. Genetic structure of a population of the endangered star cactus (*Astrophytum asterias*) in southern Texas. *Southwestern Nat.* 57(2):182-188.
- Texas Parks and Wildlife Department. 2012. Reintroduced star cactus monitoring data, Las Estrellas Preserve, November 2012. Unpublished data.
- U.S. Fish and Wildlife Service. 2003. Recovery Plan for Star Cactus (*Astrophytum asterias*). U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service. 2013. Star Cactus (*Astrophytum asterias*) Five-year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Corpus Christi Ecological Services Field Office, Corpus Christi, Texas.